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MEMOIRS

OF THE

GEOLOGICAL SURVEY

OF

THE UNITED KINGDOM.

Figures and Descriptions

ILLUSTRATIVE OF

BRITISH ORGANIC REMAINS.

DECADE IV.

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BRITISH FOSSILS.

DECADE THE FOURTH.

All the plates and descriptions in this Decade are devoted to fossil Echinodermata of the order *Echinoidea*.

The genera selected for illustration are *Temnechinus*, *Acrosalenia*, *Hyboclypus*, *Hemipneustes*, *Ananchytes* with its section *Holaster*, and *Cardiaster*. The geological age of the first is Upper Tertiary, of the second and third Oolitic, of the remainder Cretaceous. Several of the species are represented for the first time.

Temnechinus is a genus remarkable for its species being at present known only as fossils of the Coralline and Red Crags; it is now characterized for the first time.

The examples of *Acrosalenia* selected are both remarkable for their beauty and their very perfect condition. They are also of much interest, one on account of the rectification of its true generic position, which I have been enabled to make through the aid afforded by very perfect specimens: the other, because of the complete preservation exhibited by the specimens described of parts too often lost in fossil Echinoderms. I have appended to the descriptions of these *Acrosaleniæ* brief characters of some new species of this interesting oolitic genus.

Hyboclypus is illustrated by the finest and largest species of the genus, one discovered during the researches of the Geological Surveyors.

Hemipneustes, to which genus I unite *Toxaster*, is now for the first time authentically represented by a British example, remarkable for its novelty and for the light it throws upon the mutual affinities of those genera of *Echinoidea* which have excentric mouths.

The well known genus *Ananchytes* is combined (as indeed it was formerly by Lamarck) with *Holaster*. In selecting the common *Ananchytes ovata* of the Chalk for the subject of a plate and description, I have been influenced by the necessity of clearing up the confused synonymy of this fine fossil, and of settling the numerous spurious species which have been constituted out of its varieties, or from imperfect figures contained in old works.

Cardiaster is a new genus, lately constituted by myself for some remarkable and interesting sea-urchins, intermediate in their characters between *Ananchytes* and the true *Spatangidæ*. To the account of the species figured I have added notices of all the forms of this curious type which are known to me as British.

EDWARD FORBES.

October, 1852.

BRITISH FOSSILS.

Decade IV. Plate IX.

CARDIASTER GRANULOSUS.

[Genus CARDIASTER. Forbes (1850). (Sub-kingdom Radiata. Class Echinodermata. Order Echinoidea. Family Ananchytidæ.) Body cordate, tumid or depressed; lateral ambulacra having the upper part of their avenues slightly dissimilar; all the ambulacra convergent on the vertex, the anterior one lodged in a strongly marked sulcus with angulated sides. A fasciole passing beneath the anus and continued on the sides. Apical disk elongated, and composed of four perforated genital and five perforated ocular plates. Tubercles perforate, their bosses crenulate. No dental apparatus.]

Diagnosis. *A. ambitu regulariter cordato, dorso depresso, tuberculis primariis anticis conspicuis.*

Synonyms. *Spatangus granulosus*, Goldfuss, Pet. Germ. p. 148, pl. 45, fig. 3. (1826-33.) Desmoulins, Tabl. Syn. p. 410.

Spatangus cordiformis, Woodward, Geol. Norf. p. 50, pl. 5, fig. 6. (1833.)

Holaster granulosus, Agassiz, Prodr. Ech. p. 16. Agassiz and Desor, Cat. Rais. des Echin. in Ann. des Sc. Nat. 3d ser. vol. viii. p. 27.

Holaster equalis, Portlock, Geol. Rep. Londonderry, &c. p. 355. pl. 17, a. b. c.

Cardiaster cordiformis, Forbes, Ann. Nat. Hist. 2d series, vol. vi. p. 443.

On a recent visit to Ciply I had an opportunity of collecting the *Spatangus granulosus* of Goldfuss *in situ*, and recognized in it the same Echinite which has been noticed and figured by Mr. Samuel Woodward, in his "Outline of the Geology of Norfolk," under the name of *Spatangus cordiformis*. The flint casts from the chalk of the north of Ireland, described by Colonel Portlock under the name of *Holaster equalis*, and now in the collections of the Geological Survey, evidently belong to the same species.

I constituted this genus for the species now represented and described, and also for the curious *Spatangus excentricus* figured in Woodward's work, above cited. Finding that there is a distinct fasciole present in these urchins, and that this character is accompanied by peculiarities in the ambulacra, and, as far as I know, invariably by the presence of a deep anteal sulcus with carinated sides, I felt warranted in separating them generically from the *Holasters* with which they had previously been associated.

The *Spatangus ananchytis* of Leske, quoted by Lamarck with doubt for his *Ananchytes cordata*, is evidently a *Cardiaster* in a

peculiar mineralized condition similar to that exhibited by examples from cretaceous beds near Biarritz, which, judging from a specimen communicated by Mr. Pratt, seem to be very closely allied to if not identical with *Cardiaster granulosus*.

The outline of this elegant fossil is regularly cordate. In front it is deeply furrowed by the sulcus for the odd ambulacrum, which excavation has angulated but sloping margins. Behind it is obtusely truncate. The general form is expanded, usually as broad as long. The back is depressed, the apical disk nearly central, the hinder interambulacral segment gently arched and declining, the vent placed low, the margins of the body rounded yet somewhat compressed, the base flattened yet slightly convex, the mouth close to the anteal margin and at the extremity of the deep groove, that terminates the odd ambulacral furrow. The test varies in degree of convexity and expansion, but on the whole is very constant in form. All the dorsal plates are thickly covered with minute granules interspersed with tubercles, the latter consisting of a perforated knob placed on a crenulated boss, and surrounded by a smooth areola. These tubercles are very unequal. On the anterior interambulacral spaces, but confined to their inner halves, are two rows of tubercles much larger than any of the others. A similar series of large tubercles runs along the carinated portion of the posterior interambulacral area, above the vent. On the under surface the tubercles are thickly grouped and moderately large, especially near the sides, and on the lanceolate post-oral spinous space; but there are only granules on the two broad avenues formed by the inferior continuations of the posteal ambulacra, or on the central portion of the anteal ambulacrum.

In the dorsal portion of the odd ambulacrum the avenues of pores are homogeneous throughout, the pores of each pair are placed close together, and the pairs become more distant as the plates become larger. There are about 28 plates visible in a well grown example. The antero-lateral ambulacra are sub-petaloid in their upper part, and unsymmetrical in consequence of the pores of each pair being wider apart in the outer row than in the inner, and moreover being united by a deeper groove. There are about 24 pairs of pores in the broader or subpetaloid portion of each series, they are closely approximated, and those that are below widen out; the outer series is slightly arcuated. In the postero-lateral ambulacra the two series are nearly similar, and there are about 18 pairs of pores in the upper or subpetaloid portion of each series. There are about 9 plates in each series in the dorsal portion of the

lateral interambulacral segments, and 10 above the vent in the posterior segment. The infra-anal portion of the latter is composed of two series of five irregularly polygonal plates each; they are remarkable for presenting gibbosities at regular intervals. In the inferior portions of each postero-lateral ambulacrum there are 7 plates in each series. These are polygonal, large, and elongated, and bear the pairs of pores, which are minute and oblique, close to their inner angles. The pores of the ambulacra around the mouth form an obscure star.

The fasciole passes beneath the anus with a curve, and runs along the sides just above the margin, but becomes obscure or lost upon the anterior interambulacral segments. It is narrow, and free from intermingled tubercles. On bad specimens it can hardly be traced, but upon good ones is very evident.

The apical disk is covered with granules similar to those of the neighbouring plates, so that its elements are but obscurely defined; it is composed of four perforated genital and five perforated ocular plates. An imperforate genital plate is also present, but insignificant. The madreporiform body is very indistinctly marked. The two postero-lateral genital plates are long, and cause a considerable separation of the summits of the two hinder ambulacra from the other three. In flint casts there are strong indications of the presence of a sand tube like that in *Ananchytes ovata.*

Cardiaster granulosus grows to a considerable size. Moderately large and evidently adult specimens in the Museum of Practical Geology, to which they were presented by Mr. S. P. Woodward, measure 2 inches and $\frac{5}{12}$ths in length, the same in breadth, and 1 inch $\frac{1}{12}$th in height. Other examples have a greater height in proportion to the breadth, or a greater length in proportion to the width.

Locality and Geological Position. First observed as British by Mr. Samuel Woodward, who recorded it (*Spatangus cordiformis*) as rare in the Upper Chalk at Harford Bridge, and as common in the "Medial Chalk" at Swaffham and Thetford, all Norwich localities. The *Holaster æqualis* of Colonel Portlock has been already noticed as identical with it (the original specimens have been compared), and was found in the Chalk of Londonderry.

Explanation of the Plate.

Figs. 1. 2. 3. and 4. Different views of a Norwich specimen of *Cardiaster granulosus.*
Fig. 5. A flint cast; one of the original specimens of *Holaster equalis* of Portlock.
Fig. 6. Ambulacral and inter-ambulacral plates from the centre of the sides.

Fig. 7. A portion of the lateral fasciole, with the neighbouring surface, much magnified.

Fig. 8. Tubercles and granules of the dorsal surface, magnified.

Fig. 9. Tubercles and granules from under surface.

Fig. 10. Large tubercles and granules of the margins of the anterior sulcus.

List of British Species of Cardiaster.

1. *Cardiaster granulosus.* (Described in this Decade.)
2. *Cardiaster excentricus.* (Described in this Decade.)
3. *Cardiaster rostratus.* (Described in this Decade.)
4. *Cardiaster pygmæus*, Forbes. Ann. Nat. Hist. 2d ser., vol. vi. p. 444. (noticed only.)

   c. *minutus, ovatus, ambitu cordato, ambulacris tuberculisque inconspicuis, dorso sub-carinato, ano alto.*

   This little species is common in the Chalk of Dover, where good specimens have been found by Mr. C. F. Cockburn, and presented by that gentleman to the Museum of Practical Geology. The ovate outline, apparently smooth surface (under the lens scattered primary tubercles are seen among minute granules), simple and narrow poriferous avenues, strongly carinated anteal sulcus, subcarinated posteal segment, and high posterior truncation with the vent at the upper part, strikingly characterize it. A middle sized specimen measures $\frac{6}{12}$ths of an inch in length by $\frac{5}{12}$ths in breadth, and $\frac{4}{12}$ths in height. Its proportions vary considerably.

   All the above are from the White Chalk.

5. *Cardiaster suborbicularis* of Defrance, Brongniart, and Goldfuss (under the genus *Spatangus*). This is the *Holaster carinatus* of Agassiz. In the Catalogue Raisonné this name is made synonymous with *Spatangus nodulosus* of Goldfuss and *Spatangus planus* of Mantell, but the former appears to me to be the *Holaster lævis* of Brongniart, and the latter to be perfectly distinct from either.

   Of *Cardiaster suborbicularis* I have seen only one British specimen, which on comparison with French examples appears to be truly referable to this species. It is from the Upper Greensand of the neighbourhood of Osmington in Dorsetshire, where it was obtained by Mr. E. H. Bunbury, who presented it (as part of his fine cretaceous collection) to the Museum of Practical Geology.

6. *Cardiaster fossarius.* The *Spatangus fossarius* of Miss Benett. This is the *Holaster Greenoughii* of Agassiz. With us it occurs in the Upper Greensand of Warminster.

7. *Cardiaster bisulcatus.* In the Museum of Practical Geology there is a *Cardiaster* from the Greensand of Blackdown, remarkable for the small tubercles in proportion to its size, and the great width of the hinder lateral poriferous avenues. It seems to be identical with the *Holaster bisulcatus* described and figured by M. Albin Gras in his "Oursins fossiles de l'Isere," p. 62, pl. 4, fig. 7. 8. He obtained it from the Gault of Ravix.

8. *Cardiaster Benstedis*, sp. nov.

   In the Lower Greensand of Maidstone several examples of an urchin apparently a true *Cardiaster* have been found, distinct from any of our other species. It may be characterized thus :

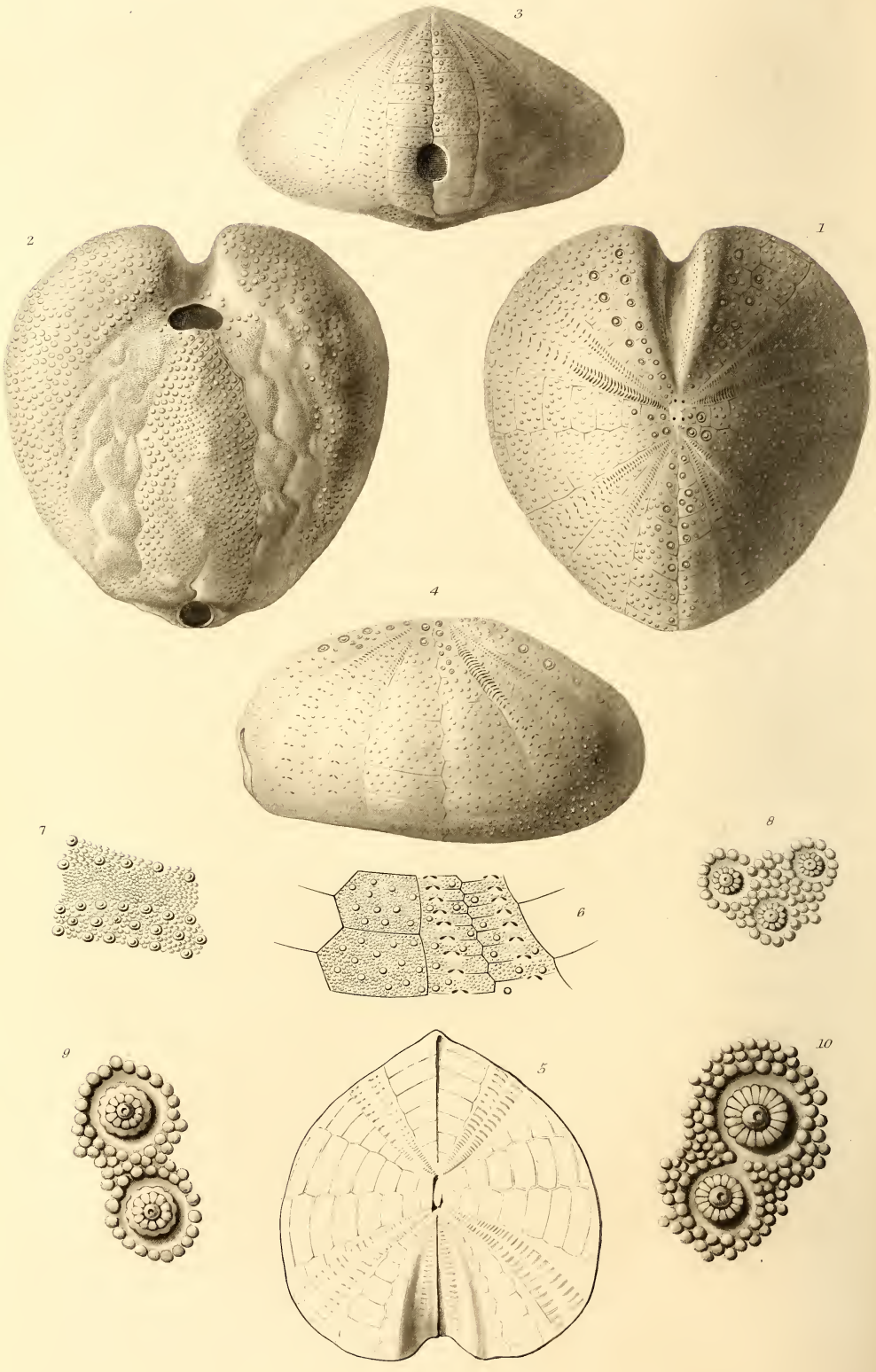
   c. *late cordatus, subhemisphæricus, dorso rotundato, seriebus pororum omnibus angustis subequalibus.*

   The anterior sulcus is strongly marked and wide below. The back is gently curved. The vent is medial in position as compared with the height. The poriferous avenues are all remarkably narrow, and the hinder ones as broad as the antero-laterals. The surface of the test is too imperfectly preserved to be described. Specimens have been presented to the Museum of Practical Geology by Mr. E. H. Bunbury and Mr. Morris.

October, 1852. Edward Forbes.

Geological Survey of the United Kingdom.

CARDIASTER
(Cretaceous)



CARDIASTER GRANULOSUS — *Goldfuss.*